SCIENCE EDUCATION AT SECONDARY LEVEL IN INDIA, SINGAPORE AND THE USA: A COMPARATIVE STUDY

SYNOPSIS OF THE THESIS SUBMITTED FOR
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By

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Synopsis

Introduction

The importance and necessity of comparative science education is internationally recognised. From the similarities and differences along with various gaps found among the three countries through the study have been resulted in different policy making of a nation. The present study compares India with the rest of two powerful countries who have already established their superiority through different fields.

The study reflects the detailed discussion about science curriculum at secondary level of three countries along with its historical development.

Execution of science curriculum should be done with proper science teaching strategies. This is also mentioned through this study for aforesaid three countries.

Professional development of science teachers has been discussed through this study for the mentioned three countries.

The level of performances and their comparisons in different international tests among the three countries have been discussed throughout the study.

Chapter-wise findings have been extracted and presented here based on the research objectives framed by the researcher:

Objective 1

To study the science curriculum of India, Singapore and the USA at secondary level comparatively

The purpose of this study is to discuss and compare the curriculum for school science education between India, Singapore and the USA at secondary level. Researchers followed qualitative

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data analysis methodology along with a comparative investigation strategy. This study compares the school education system, analyses the science curriculum, and compares the curriculum of school science education between India, Singapore and the USA. The study delimits middle stage and secondary stage both as secondary level.

In India and Singapore, the science curriculum is set up both by MOE of that countries, whereas for the USA the local district and state board are responsible for construction of science curriculum. India operates (5+3+2+2) education system till date (as the effect of NEP 2020 is not prevailed in all states) whereas Singapore follows (6+4+2) education system. In the USA, there are many types of school education system is followed. But, maximum variation occurs in the middle stage and secondary stage. The fundamental difference is India's curriculum has emphasized rote learning over creativity, whereas Singapore cultivates creativity among its pupils. The USA, incorporates more advanced engineering practices in STEM based classroom. Laboratory practice is encouraged in Singapore and the USA from lower secondary and middle school onwards; whereas for India it is practiced only from higher secondary level. Through NEP 2020, Govt. of India has stepped forward to make up this unavoidable gap.

Objective 2

To study the science teaching strategies of India, Singapore and the USA at secondary level comparatively

To meet the curricular goals of science education effectively and efficiently, proper handling of science curriculum is necessary. It can be effectively carried out by proper science teaching strategies maintained by the science teacher. Science teaching strategies should be maintained from very beginning i.e. lower secondary level when the subject is introduced in school curriculum as separate disciplines. In this study, the science teaching strategies of India, Singapore and the USA has been discussed comparatively. This is a qualitative study based on

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document-based analytical approach. It is found that, India has lagged behind than Singapore and the USA in case of applying Information and Communication Technology (ICT) and Science Technology Engineering Mathematics (STEM) classroom more effectively for science teaching at secondary level. Though various attempts for innovative science teaching strategies were made after NCF- 2005, but practically all of them were not successful. Activity-based, inquiry-based, blended, student centric teaching strategies are highly solicited for India for better performance in various International tests like, Programme for International Student Assessment (PISA), Science Olympiads etc. Through NEP-2020, India has started to nurture creativity and incorporate critical- thinking skills in science teaching more vividly.

Within India, Singapore and the USA, though India has started its journey in Science Olympiads with comparatively lagged ranking just like in Mathematics Olympiad, but the country has proved itself more improved and developed year by year, not only with its hard effort, but also with its strong determination and will power. The science curriculum and its manifestation plays a vital role in this regard. Without well organised and well-structured teaching strategies, this manifestation can't be possible. Here the necessity of good and organised teaching strategies arises. Singapore and the USA has applied effectively more advanced, technology- based, student-centric and above all practical-based teaching strategies in science. In India, science teaching strategies also follow the above four features but not vividly and effectively. After NCFSE-2023, India has stepped forward to fill up the gap.

Objective 3

To study the professional development of science teachers of India, Singapore and the USA at secondary level comparatively

The study compares the professional development of school science teachers at the secondary level in India, Singapore, and the USA. It follows a qualitative method pursuing document-

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based analysis. The comparison reveals that for India, secondary science teachers' professional development is generally centred on some theoretical knowledge including some routine-based practical implications. For Singapore, the country follows reform-type and school-based professional development, followed by proper mentoring system, research publication, and ranking and promotion system. In the USA, professional development follows inquiry teaching in a student-friendly learning environment envisioning core ideas, practices, and coherence through various teaching shifts mainly after NGSS.

The comparisons between secondary science teacher education and their PD existing in India, Singapore, and the USA has been discussed here. Through this study, the emergence and reflection of NGSS in American science teachers' PDs has been shown with necessary teaching shifts and requisite PD activities concerning PD needs of science teachers more precisely focusing on core ideas and crosscutting concepts. The advanced PD infrastructure of Singapore is depicted which is reflected through its performances in various international tests. In Singapore, the reform-type and school-based PD are more useful and easily accessible in practical situations, whereas in India, the PD programs are confined to theoretical knowledge mainly. Especially, for newly appointed teachers mentoring system is highly needed. Secondary science teachers should be encouraged through a suitable ranking and promotion system supported by adequate research publication and inquiry-based teaching for the betterment of science teaching. Through NEP 2020, India has stepped forward to improve its secondary science teacher education and PD programs maintaining an international level with an aim to achieve 21st century competencies to be adjusted in ever changing globalized world.

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Objective 4

To study the level of performances in science Olympiads [IJSO (International Junior Science Olympiad), IPhO (International Physics Olympiad) and IChO (International Chemistry Olympiad)] of India, Singapore and the USA comparatively

The study is about the performances of India, Singapore, and the USA in Science Olympiads. Here the Science Olympiads are delimited to the International Physics Olympiad (IPhO) and International Chemistry Olympiad (IChO). The preparation of three countries from class 6 to class 12 for IPhO and IChO is depicted here. The study shows the comparison of their performances in those international events. The study reflects the preparation of India and its marvellous performance among the three countries in the International Junior Science Olympiad (IJSO). The study employed the current document-based analytical approach in the few-country comparison method. The performances of the USA in IPhO and IChO are outstanding. Despite, being a very small country, Singapore also performs very well. Though India started late participating, it wonders all with its mesmerising performances in those events. A proper goal-oriented science curriculum along with vigorous laboratory practice is necessary for India's better performance.

Despite having the third highest population in the world, the USA performed very well throughout IPhO and IChO. Whereas India with the highest population in the world has lagged in those events. This is due to the planned, goal-oriented science curriculum of the USA which is based on the Next Generation Science Standards (NGSS) in Science Technology Engineering Mathematics (STEM) based classrooms of the USA. Though India started late, the country tried its best to achieve its best. India has achieved 4th position just after the USA (3rd) in IPhO, 2023 which is more praiseworthy than the result in IPhO, 2022: when the country ranked 9th with the USA in 4th position. Singapore with a very small population has managed

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to start its journey 9 years before than India in both IPhO and IChO. It obtained 9th rank as same as India in IPhO, 2022 but lagged in IPhO, 2023 with its 14th rank. Simultaneously, Singapore performed extraordinarily in IChO, 2023 by occupying 1st rank and made a history.

Within India, Singapore, and the USA, though India has started its journey in Science Olympiads with a comparatively lower ranking just like in Mathematics Olympiad, the country has proved itself more improved and developed year by year, not only with its hard effort, but also with its strong determination and will power.

Concluding observations

On the basis of the researcher's study, some concluding observations has been drawn as the outcome of the study.

I. The study includes its new findings in different aspects like curriculum of science education at secondary level, science teaching strategies at secondary level, professional development of science teachers at secondary level and performances in science Olympiads at secondary level of India, Singapore and the USA. Here the secondary level defines from grade 6 to grade 12 as described in the definition of the related terms in chapter 1.

II. The education system of India and Singapore are totally controlled and regulated by MOE; whereas for the USA it is decentralized and depends from state to state. India operates (5+3+2+2) system till date as NEP 2020 is not in run at every state; whereas Singapore operates (6+4+2) system. In the USA, it is varied from state to state.

III. Singapore rears their students to be creative through inquiry-based science teaching. The USA has most improved and developed STEM based classroom in run. Incorporation of creativity, laboratory activities, STEM based classroom practice has

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been emphasized in science curriculum at secondary level for India after incorporation of NEP 2020.

IV. From the results of various international tests, it can be concluded that the science curriculum and its manifestation through well organised and well-structured teaching strategies plays a vital role. Here the necessity of good and organised teaching strategies arises. Singapore and the USA has applied effectively more advanced, technology-based, student-centric and above all practical-based teaching strategies in science. From NEP 2020, the application of these four factors has been more strengthened.

V. Through NGSS, American science teachers' PDs has been emerged with teaching shifts and PD activities necessary for change in PD of science teachers more accurately which focuses on core ideas along with crosscutting concepts. The PD structure of Singapore is more advanced which follows reform-based PD and school-based PD as per their needs. Both Singapore and the USA have used practical-based PD; whereas in India in most of the case, theoretical-based PD is used. Monitoring system for pre-service teachers, ranking system and promotion system for in-service teachers with adequate research publications are highly needed for India. NEP 2020 has been applied to make up the gap.

VI. Performances of mentioned three countries in IJSO, IPhO and IChO have been discussed in this study. Performances of India over last six years in IJSO has been outstanding. Performances of Singapore are also remarkable. But the USA has remained non-participant from the beginning till date. In case of IPhO and IChO performances of Singapore and the USA are comparatively more glorious than that of India. It is mainly due to their goal-oriented science curriculum and laboratory-based activities from middle school section throughout. Through NEP 2020, steps have been taken regarding these.

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VII. India is hoping to become a powerful country in terms of science, technology, engineering, mathematics, power, economy and other fields of knowledge. Therefore, it is inevitable to study about science from the very school level and thus inculcating the scientific literacy among people from the school level.

VIII. Performance of India in IJSO is magnificent due to its composite science curriculum and allied teaching strategies in middle school section. For India, more advanced, practical-based, hands-on activity oriented, creativity nurturing, critical thinking based science curriculum is needed mainly for secondary section i.e. grade 9 and 10 which should be improvised from grade 6 onwards. It should be implemented vividly and effectively with proper science teaching strategies under the supervision of trained and professional science teachers completing requisite PD course. Thus, the performances of our country has been magnified in various international tests which will set it to the top most position in different tests like PISA, IPhO and IChO etc.

Conclusion

To make India scientifically powerful it is necessary to make it advanced with compared to other nations. Through this study a comparative analysis as well as critical estimation of science education of India, Singapore and the USA has been done with respect to overall educational structure, science curriculum, science teaching strategies, professional development of science teachers and performance analysis of the said countries with respect to IJSO, IPhO, IChO which will help for further improvement of our country.

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